JOURNAL
OF THE
BOMBAY NATURAL HISTORY
SOCIETY

1977 DECEMBER Vol. 74 No. 3

An ecological reconnaissance of the proposed Jawahar National Park[1]

S. Sathis Chandran Nair[2]
P. Vijayakumaran Nair[3]
H. C. Sharatchandra[3]
and
Madhav Gadgil[3]

(With five plates & four text-figures)

The proposed Jawahar National Park embracing an area of 2000 sq. kms will comprise of the Bandipur and Nagarhole national parks (Karnataka) and Mudumalai (Tamilnadu) and Wynad (Kerala) wild life sanctuaries. It is one of the most extensive contiguous forested areas in Peninsular India, and probably harbours the largest population of the elephant in India. The undulating terrain lies at the trijunction of the Western Ghats, the Nilgiri hills and the Deccan plateau. Its natural vegetation is primarily of the moist deciduous and dry deciduous types, with patches of evergreen forest and scrub. This has been replaced in many parts by degraded scrub forest and by plantations and cultivation. The mammalian fauna includes the Indian elephant, gaur, sambar, chital, wild boar, mouse deer, black-naped hare, sloth bear, dhole, grey or hanuman langur and giant squirrel, occurring in good numbers, at least locally. Rarer species include the four-horned antelope, barking deer, panther, tiger, jackal and the striped hyena. In addition, the Nilgiri tahr, Nilgiri langur and liontailed macaque occurred in areas very close to this sanctuary complex until very recently. If the Brahmagiri sanctuary of Coorg were to be included within the Jawahar National Park, these species could be reintroduced there. Blackbuck could thrive in Masingudi area of Mudumalai. With these introductions, this sanctuary complex could harbour all the major South Indian mammals. It has a good population of peafowl locally, and crocodiles exist on Kuruwa islands close to the sanctuary, and in the river Nugu.

[1] Accepted April 1977.
[2] Department of Zoology, University of Kerala, Trivandrum-695 581.
[3] Centre for Theoretical Studies, Indian Institute of Science, Bangalore-560 012.

This entire area was surveyed on foot by our team over three months during monsoon 1975. Our party mapped the areas of wild life concentration, and studied the various environmental factors affecting the wild life. The Kabini reservoir, along with the encroachments in the vested forest of Pulpally have drastically reduced the area of wild life habitat and have almost completely split the habitat into two, severing many traditional migration routes of the elephants. Plantations, and other disturbances have also sharply reduced the summer range of elephants in the forest in the Wynad areas. Most of the forest is subject to serious overgrazing by domestic cattle and forest fires in the dry months. The cattle also bring in diseases like the rinderpest which almost wiped out the gaur population of this region in 1968. The forest department is inadequately equipped to control poaching, and poaching of all animals ranging from tiger and elephant down to regular trapping of blacknaped hare and mouse deer is reported. We urge strong action on many fronts to conserve this finest of elephant forests in India.

CONTENTS

I. Introduction

ELEPHANT, the largest and the most venerated of our wild animals, still survives in sizeable numbers along the Western Ghats in Peninsular India, in Orissa, Bihar, West Bengal, Assam and Uttar Pradesh. It is likely that the elephant has suffered the least among our larger wild life in terms of actual decline in numbers over the past half-a-century. Elephant meat is not consumed in India, and the only item of value to the hunter or poacher is the tusks. The tuskless females are therefore, relatively immune from hunting pressure, and so is the tuskless makhna males. Religious sentiment has also been in favour of not killing this magnificent animal which gave Lord Ganesha his head. The hunting and poaching pressure on the elephants has therefore, been relatively light. Capture for domestication has been more significant, and must to an extent have affected the wild populations. But elephant takes domestication well, and tame elephants at forest camps continue to mingle and mate with wild animals; so this capture too does not withdraw too many animals from their forest habitat.

Elephants survive for more than sixty years, and are tolerant of a wide variety of habitat conditions ranging from dry scrub to moist deciduous forest. They also feed widely on crops like ragi, paddy and sugarcane. Spared of heavy mortality at the hand of man, the fate of all other wild animals in India, this long-lived and versatile beast has survived in good numbers to this date. There is, however, no cause for complacency. Although an animal may maintain populations far in excess of the carrying capacity of the environment for the period of one or two generations, it cannot continue to do so indefinitely. The numbers that the elephants are maintaining today are those more appropriate for an environmental carrying capacity of half-a-century ago. The elephant habitat has drastically deteriorated in the recent decades, and it is a matter of but a short time before the elephant numbers also crash in keeping with the very much diminished carrying capacity of their habitat. In the process they may inflict considerable damage on the rest of the forest ecosystem.

Elephant has been intimately associated with the culture and people of India for the past two thousand years or more, and there is a vast lore on elephants in India. Little scientific information is however, as yet available, the only scientific accounts being those of Singh (1969) and Krishnan (1972) for India and McKay (1973) for Sri Lanka. These accounts suggest that the elephant populations of the northern and eastern parts of the country are not very substantial, and that the Western Ghat population is by far the largest. This population has never been properly surveyed, but it was possible for us to obtain estimates of it from experienced foresters. We have put together a tentative picture of the distribution of elephants on the Western Ghats on the basis of such information (fig. 1). It must be stressed that these are all merely educated guesses, and likely to be correct only to the very rough order of magnitude. It nevertheless provides a broad picture of the elephant distribution on the Western Ghats.

It will be evident from this figure that the best elephant habitat is the area proposed to be constituted as the Jawahar National Park, embracing the present-day national parks of Bandipur and Nagarhole in Karnataka, and the wild life sanctuaries of Mudumalai in Tamilnadu and Wynad in Kerala. We therefore, chose this area for an exploratory study of the elephants on the Western Ghats. We have been engaged in ecological studies in one part of this sanctuary complex, namely, Bandipur, since May 1974 and this work furnished the background for the present study (Sharatchandra & Gadgil 1976). The present survey

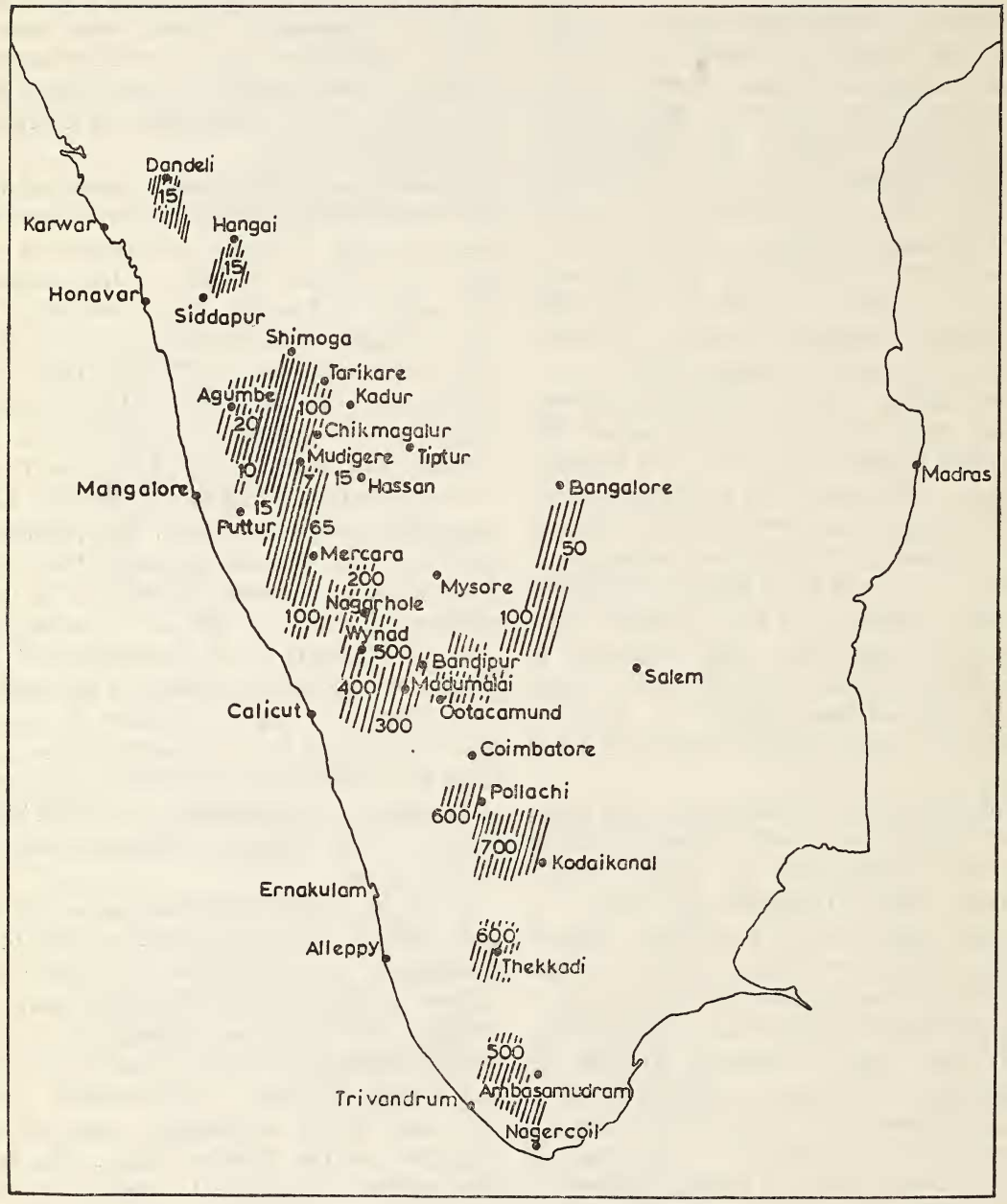

Fig. 1. Distribution of the Asian elephant population in South India. Population estimates are only approximate and are based on information supplied by the forest departments.

itself was carried out over a period of three months from July to October, 1975, during which time almost all of the total area of 2,000 square kilometres of the proposed Jawahar National Park was visited by one or more of us on foot.

Although primarily directed towards developing the methodology for estimation of elephant populations, the survey yielded considerable information on the vegetation, other wild life and the environmental factors affecting this ecosystem. In view of the great significance of the survey area for conservation of wild life in Peninsular India, we felt that it would be useful to present this information, albeit rather incomplete, in a systematic fashion, and we do so in the account that follows.

II. Locality and Methods

The area surveyed is the complex of national parks and wild life sanctuaries of Bandipur and Nagarhole in Karnataka, Mudumalai in Tamilnadu and Wynad in Kerala, which is proposed to be united into the Jawahar National Park. In addition, we visited parts of Brahmagiri sanctuary in southern Coorg of Karnataka, Padri (North) and Kuruva reserve forests in Wynad in Kerala and Kalmalai reserve forest near Mudumalai in Tamilnadu. This area forms an arc like tract lying within latitudes 11° 13′ N to 12°15′ N and longitudes 76° 5′ E to 76°55′E (fig. 2). The terrain is hilly, the altitude ranging from 700 m to 1000 m in the plateau areas with a number of peaks rising up to 1500 m. This area forms the largest continuous tract of good elephant forest in Peninsular India, and includes the famous old Khedda capture area of Kakankotte and the pit capture areas of Tittimati and Mudumalai—Muthanga forests. This locality includes most of the principal vegetation types and larger mammals of Peninsular India. The only major vegetation type which is poorly represented is the montane evergreen forest, and the two major mammalian species lacking are the Nilgiri tahr (*Hemitragus hylocrius*) and the liontailed macaque (*Macaca silenus*). Even these were probably wiped out only in recent times. The locality is also subject to the whole gamut of anthropogenic factors affecting the elephants including plantations, cultivations, forest fire, cattle grazing, submersion due to reservoirs, elephant capture and poaching. It therefore, makes for an interesting study, not only of nature in the wild, but also of all the human influences on it.

The locality was well-suited for an extensive survey of this type, because although it includes steep hills and riverine tracts, it is mostly an easily negotiable plain with moist deciduous forest. It has well-developed lines of communication and other facilities making for easy access everywhere. The forest departments of all the three states had most kindly put these facilities at our disposal.

The initial survey lasted from 15th July to 10th October, 1975. This particular season, the peak rainy months of south-west monsoon, was selected because—

(*a*) Elephants from heavier rainfall, more inaccessible terrains such as the Nilgiri escarpments, Coorg western ghats and Wynad western edge congregate in the survey area. Although this might give an exaggerated population count for the survey area, some information on the status of the entire population could then be gathered.

(*b*) The lusher, plentiful forage and adequate water during the rainy months prevent the animals from ranging too widely hence reducing chances of duplication of counts.

(*c*) Though the thicker undergrowth reduces visibility, it helps undetected close approach by investigators.

(*d*) The more humid cool rainy months permit greater physical exertion, i.e., greater coverage of area per day, than is possible in

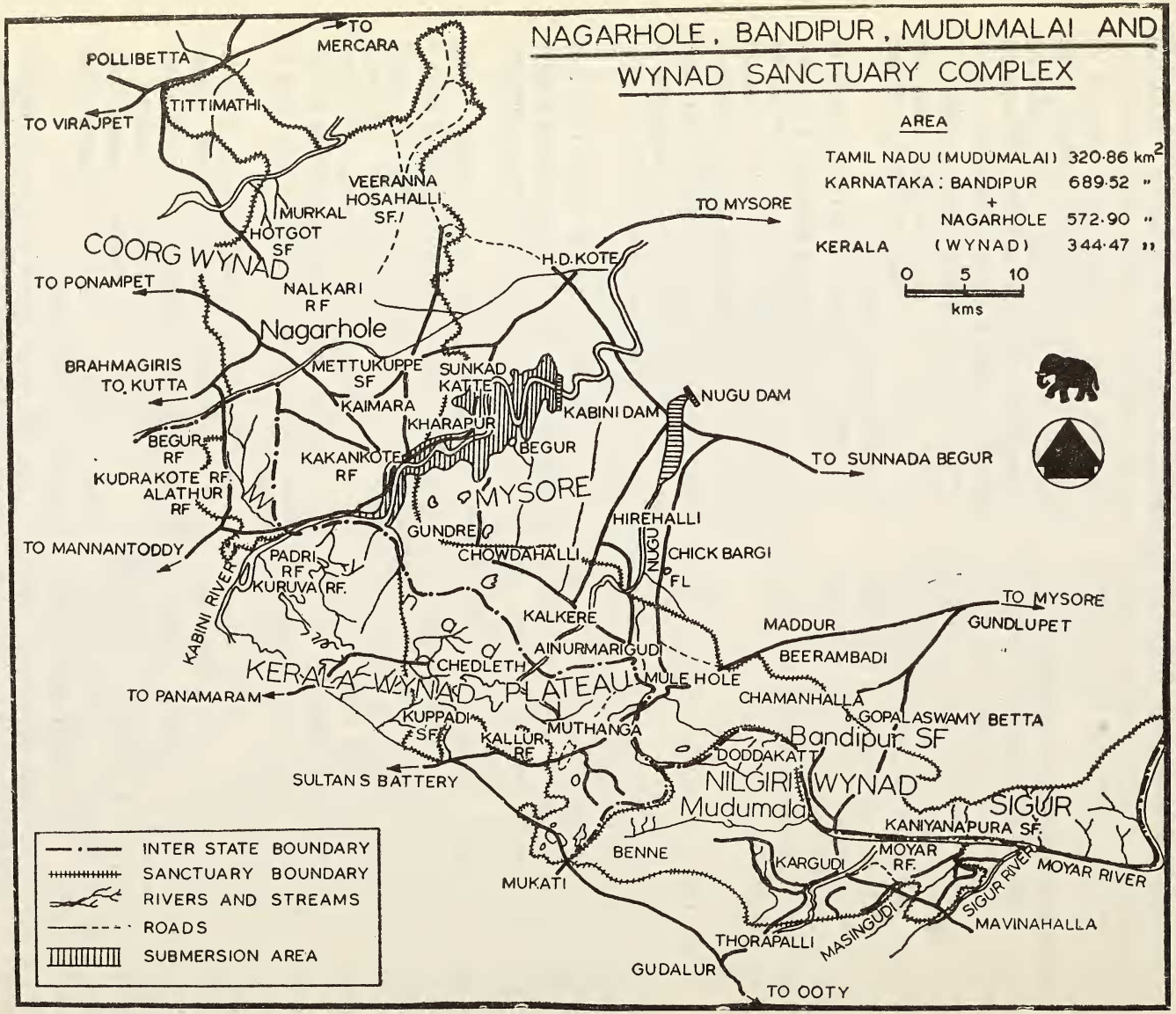

Fig. 2. Map of the proposed Jawahar National Park.

NOTE: The correct area of Kerala (Wynad) is 473·72 sq. km and not 344·47 sq. km as shown in figure 2.

summer months when even drinking water becomes hard to get. Because of this it was possible to survey the entire area in the short time available.

(*e*) Vegetational data could be gathered only during the lush period before the plants shed their leaves or dry up and get burned in annual summer fires.

(*f*) During the rainy season the forests and the wild life are least disturbed by cattle graziers, minor forest produce collectors, forestry operations etc.

The survey was conducted by a party of 4 biologists who covered the terrain on foot. The survey area was divided into approximately 10 sq. kilometre compartments with the aid of maps and each of the compartments surveyed by one investigator with the help of a guide—a local forest tribal or an experienced forest guard. Walking in a zigzag route the entire terrain, especially, areas favoured by elephants such as swamps, stream banks, bamboo thickets etc., were traversed. Whenever herds were encountered they were approached under cover and observed through binoculars and data on the number, age classification, identifiable body marks and activity engaged in were recorded. Based on elephant tracks and dung, approximate number of animals in the group, direction of passage, time since passing, activity engaged in (i.e. walking along, feeding, resting etc.) were noted. Whenever possible, circumference of clear imprints of right foreleg was measured as a possible individual identifying feature. Distribution and degree of abundance of other wildlife, based on sightings as well as spoor marks were also recorded besides information relating to vegetation and soil.

The help of Kurubas especially those who have worked in various elephant camps was invaluable for carrying out the elephant tracking. Although it was attempted to cover as much area as possible within the sanctuary complex, due to various unavoidable circumstances certain areas were surveyed only fleetingly. The north-west part of Benne (compartments 29 and 38), Gopalaswamy betta area of Bandipur, Balijadihalla—Kallalla area north of Mulehole, Gulibetta, Chelvarayana Katte, Alangikatte area of Gundre and Kadatalkatte, Vanakegundihalla area of Nisna Begur as well as some areas near Chowdahalli could not be exhaustively surveyed.

III. Physical Features

The survey area lies at the junction of the Western Ghats to the north-west, the Nilgiris to the south-west, and the Mysore plateau to the east. The western tracts are wetter, and are characterized by swamps (or wyals) in the low lying areas. This terrain is therefore, known as wynad or the land of swamps.

The wynad region is subdivided into the Coorg Wynad in north, the Nilgiri Wynad in south, with the more extensive Kerala Wynad in between. This Wynad passes over into the drier Mysore plateau to the east, with the very dry Sigur plateau lying at the southeastern end.

(1) **Coorg Wynad :**

This plateau is indistinguishable from Kerala Wynad stretching north-east from Kabini along a main northern axis up to Brahmagiri range (Maximum elevation 1736 m) in north-west and Mysore plateau in the east. All of Brahmagiri sanctuary and part of Nagarhole National Park fall in this sub-division. (Photograph 1). This is a heavy rainfall area which is more undulating and is drained by Kabini, Nagarhole and Lakshmantirtha, the last two flowing east and joining the Cauvery. There are many gadde or hadlu (marshes) present, many of which are under cultivation

(2) **Kerala Wynad :**

This gently undulating plateau is an eastern extension of the main western ghats with a general elevation of 700-900 metres. Its major peaks include Kalimale betta and Brahmadevar Vattom. It is gently sloping to the east and north and merges with the Mysore plateau. This area receives the heaviest rainfall and consequently is drained by a large number of perennial streams all eventually joining Kabini. The major streams are :

(1) Streams draining Kuruva (which is an island in the river Kabini) reserve ;
(2) Kadumanthodu and Naratipuzha draining eastern and western portions of Padri reserve and joining Mannantoddy puzha ;
(3) Murmavuthodu and its tributaries Kurichiyat puzha, Doddapallam and Waterfall streams draining Kurichiyat reserve ;
(4) Nulpuzha draining Nulpuzha, Mavanhalla and Rampur reserves ;
(5) Mavanhalla stream draining certain portions of Mavanhalla reserve and Rampur reserve and joining Nulpuzha forming Nuguhole ;
(6) Ammanvayal thodu—this drains Kurichiyat reserve and joins Nuguhole ;
(7) Manjathodu drains part of Kurichiyat, Kuppadi and Rampur reserve and joins Nulpuzha ;
(8) Kattihalla joins Nuguhole draining Rampur reserves ;
(9) Ammankuli thodu draining Mavanhalla and joins Nulpuzha ;
(10) Kallur thodu drains Kallur and Alathur reserves and joins Nulpuzha ;
(11) Bavelihole drains Begur, Alathur and Kudrakote reserves and joins Mannantoddy puzha which empties into Kabini.

(3) **Nilgiri Wynad :**

This extensive plateau has an average elevation of 1000 metres. Beginning from the northwestern edge of Nilgiris it stretches northwest merging imperceptibily with Mysore plateau and with Kerala Wynad to the west. It is gently undulating and slowly rises to the north to a low range of hills running east-west which includes Jainberi betta and Narathi betta (1236 m). This range forms the watershed between the dry Doddakatti area and wetter Mudumalai reserve. The Nilgiri Wynad forest includes Benne and Mudumalai reserves and a part of it formerly belonging to Nilambur Kovilakam is under cultivation now.

Mudumalai reserve is drained to the west by Bennehole which joins Nulpuzha, a tributary of Nuguhole, the latter joins Kabini. Southern part of the forest is drained by Bedarhalla and Kekkanhalla both flowing into Moyar.

There are a large number of extensive swamps (vayals) in this tract some of which are cultivated and some still intact.

(4) **Sigur Plateau :**

This is the narrow belt of land from the foot of the very steep northern edge of Nilgiris to Moyar river with an average elevation of 900 m. It is gently undulating near Masingudi and the steep Morganbetta can be considered its boundary with Nilgiri Wynad to the west. This plateau continues east beyond Masingudi to Anaikatti area outside the sanctuary. The Sigur plateau gently slopes north towards Moyar gorge and on its eastern edge merges with the Coimbatore plains. Receiving the least amount of rainfall in the entire survey area, it is dry and differs from Nilgiri Wynad forming the rest of Mudumalai sanctuary.

Sigur plateau is drained by Kadarhalla, Averahalla and Moyar. Moyar river on the northern edge has here formed the deep gorge

(up to 260 m) known as Moyar gorge or Mysore ditch. This steep sided canyon extends from the junction of Kekkanhalla with Moyar to where Sikattihalla meets with Moyar outside the sanctuary. It is almost impossible to cross the gorge except along a few regular animal paths. The Kalmalai, Averahalla and Moyar reserves fall within this Sigur plateau.

(5) **Mysore plateau :**

The major portion of the survey area falls within this topographical sub-division. This is part of the Deccan plateau with an average elevation of 1000 m. It is also gently undulating dotted by isolated hills, which include Masal betta, Jainbari betta and Shige betta, the highest of the hills being Gopalaswamy betta (1454 m). The Mysore plateau slopes gently east. Its southwestern extremity is marked by Moyar gorge. The entire area receives little rainfall. Parts of Nagarhole National Park and all of Bandipur National Park fall within this sub-division. It merges to the west with Kerala Wynad and to the northwest with Coorg Wynad. The Kabini reservoir is situated in the trijunction.

The southeastern portion of Bandipur sanctuary is drained by Moyar through its tributaries Kekkanhalla, Sikattihalla, Hebballa' Waranchi etc. The western portion of Bandipur is drained by Mulehole (Nugu), northwestern portion by Nugu and northern part by Kabini.

Moyar joins Bhavani near Peerkadavu on Coimbatore plains and Bhavani joins Cauvery. Nugu and Lakshmanatirtha also join Kabini which drains into Cauvery.

In addition to the streams, the Mysore plateau area contains about 40 tanks many of which are perennial. They appear to be man-made.

(6) **Special features :**

Marshes (vayals, gaddes or hadlus) are a common feature of Wynad plateau. They are swampy areas in between rounded hills with a meandering stream along the middle or draining the waterlogged area from one end. Their common characteristics include a deep black clayey soil that is waterlogged with 30 to 50 cm of standing water during the rainy season, a very lush grass growth in the slush and bamboo growth along the fringes. It is usually open, but is at times dotted by isolated trees or bushes. (*a*) the gentle undulating terrain with no definite direction of drainage ; (*b*) the low hills with gentle slopes resulting in slow surface run off and little percolation and an impeded but not totally arrested drainage ; (*c*) thick vegetation and thick humus on the hills retaining and letting water drain slowly in an area where rainfall is high, and (*d*) the continuous washing down of clay colloids further slowing drainage are the various reasons pointed out as causing the formation of vayals.

IV. Climate

The survey area being entirely within the plateau with an average elevation of 1000 metres, climatic extremes are not met with. Reliable climatological data from no location within the survey area is available. Temperatures range between 17°C-30°C with a mean value of 24°C. The tract receives rainfall from both southwest monsoon and northeast monsoon, with preponderance of each depending on the specific locality. Masingudi and adjacent areas receive two-third of the annual rain from northeast monsoon whereas Kerala and Coorg Wynad receive only one-third or less. Generally the entire tract receives a few heavy pre-monsoon thunder showers during April-May but southwest monsoon sets in by middle of June and lasts till August-September. Later, October-November are northeast monsoon months. The driest month is February and wettest July. In many localities mostly to the

eastern edge of the tract, there is a second peak of rainfall in October.

The annual rainfall for some locations in and adjacent to the survey area are given below based on older data.

Kerala Wynad	..	1524 mm—2540 mm
Mudumalai	..	1448 mm
Benne	..	1753 mm
Kargudi	..	1448 mm
Masingudi	..	916 mm
Gundlupet	..	686 mm
Bandipur	..	916 mm
Kalkere	..	1270 mm
H. D. Kote	..	1092 mm

There is a very perceptible gradient of increase in total annual rainfall from east to west and north to south. The heaviest rainfall is in southwest and western portions.

V. Vegetation

The dominant natural climax vegetation of this locality is the southern tropical moist deciduous forest in the wetter tracts of the Wynad and the southern tropical dry deciduous forest in the drier tracts of Mysore plateau, and scrub on the very dry Sigur plateau. In addition, there are pockets of semievergreen and evergreen vegetation.

The natural climax forest vegetation has been considerably modified either historically or recently over most of the terrain and much of the vegetation is in various stages of secondary succession. Much of the Mysore plateau was probably under cultivation at one time, as witness the numerous man-made tanks scattered throughout the forest in this area. There is historical evidence that this region was depopulated during the regimes of Hyder and Tippu Sultans in the eighteenth century and the forest cover must have come back over the past two centuries. The Wynad tracts, on the other hand, were probably always very thinly populated because of the high incidence of malaria, and the only form of cultivation historically practised must have been the shifting cultivation by tribals.

Modern forestry operations and plantations began in parts of this region over a century ago, and have been gathering pace ever since. They have become particularly intensified over the past quarter of a century. Selection fellings have opened up the forest canopy, generally followed by the invasion of *Lantana* and *Eupatorium*. Areas brought under plantation are also susceptible to invasion by these weeds, and by weedy tree species such as *Kydia calycina*. Extraction of wood, grazing and fire have changed considerably the character of many forest areas, rendering them drier and more scrubby. Extensive areas in this tract are also being put under cultivation. Many marshy areas in the Wynad are put under paddy, even inside the Reserved Forests. Large tracts of Reserved Forests were released for cultivation for settling of landless people, particularly the refugees whose lands were submerged under the Kabini reservoir. Revenue Forests have been mostly released for cultivation. Finally large tracts of vested forest in Kerala have been encroached upon by cultivators, the 25,000 acre tract of Pulpally being a particularly striking example.

All of these changes have resulted in the vegetation assuming a highly complex chequered pattern which makes it difficult for us to provide a reserve by reserve description.

(1) (*a*) Moist Deciduous :

This type of vegetation is characteristic of Nilgiri Wynad (Benne, Mudumalai and Kumbarkolli Reserves), whole of Kerala Wynad excluding the northern edge of Rampur and Mavanhalla reserves and the whole of Coorg Wynad (Begur, Kakankote Reserves and whole of Nagarhole sanctuary except the degraded portions). Economically this is the best forest

type and wildlife is rich. Moist deciduous forests occur where rainfall is between 1150 mm and 1900 mm ; where rainfall increases still further, evergreen species predominate and where rainfall is less, dry deciduous forest takes over. Typically the floral composition of this type of forest is :—

TREES

Tectona grandis
Lagerstroemia lanceolata
Dalbergia latifolia
Phyllanthus emblica
Buchanania latifolia
Ficus infectoria
Stereospermum chelonoides
Stereospermum xylocarpum
Terminalia bellerica
Grewia tiliaefolia
Terminalia tomentosa
Pterocarpus marsupium
Anogeissus latifolia
Shorea talura
Adina cordifolia
Ongeinia dalbergioides
Bombax malabaricum
Albizzia odoratissima
Schleichera trijuga

The lower canopy is composed of :—
Emblica officinalis
Grewia tiliaefolia
Cassia fistula
Kydia calycina
Gmelina arborea
Bauhinia racemosa
Butea monosperma
Bridelia retusa
Xeromphis spinosa
Zizyphus sp.
Cordia myxa

The shrub growth is composed of :—
Kydia calycina (young)
Helicteres isora
Hemidesmus indicus
Lantana camara
Desmodium sp.
Grewia hirsuta
Solanum ferox
Solanum indicum
Holarrhena antidysentrica
Eupatorium glandulosum
Vernonia sp.

Climbers are :—
Acacia concinna
Acacia caesia
Entada scandens
Calycopteris floribunda
Smilax sp.
Asparagus racemosus
Clematis sp.
Jasminum sp.
Ventilago sp.
Vitis sp.

Common grass species include :—
Cymbopogon flexuosus
Cymbopogon citratus
Imperata arundinacea
Andropogon contortus
Themeda cymbaria
Themeda imberbis
Spatholobus roxburghii

(1) (*b*) **Sub-types :**

C. R. Ranganathan in his working plan for Nilgiri Division classified this type of forest in Mudumalai into two sub-types namely: (1) a belt of non-teak forest along the southern boundary of Mudumalai range and south western portions of Benne (areas of heavy rainfall), and (2) where rainfall is less, with teak always present. Though the original floristic difference is still discernible, it has been greatly altered due to forestry operations, extraction of teak etc. These two types are discernible in the adjoining Kerala Wynad forests too.

Where teak is prominent, the forest is upto 20 metres in height, canopy is more or less closed, soil is reddish and deep, ground vegetation is thin and herbaceous, typically wild arrowroot and occasional patches of wild turmeric. Few *Helicteres*, *Solanum*, *Flemingia*, *Desmodium* etc., occur and where forest is disturbed, *Eupatorium* and *Lantana* grow in profusion. In summer, the herbaceous

cover dies off completely leaving the soil bare. Sapling density (i.e., regeneration rate) is very low. Patches of this type of forest occur on fire protected, well drained hill slopes. They are heavily worked at present and altered in Mudumalai and elsewhere. Opening of canopy results in profuse *Eupatorium* and tall grass—*Andropogon* and *Imperata*—growth. Similar patches occur in Nulpuzha, Mavanhalla, Rampur, Kurichiyat, Begur and Kudrakote reserves of Kerala and Chowdahalli—Bannurgadde areas of Bandipur and most of Nagarhole sanctuary core area where vegetation has not been unduly altered and along Kabini in Kakankote forests.

On steeper slopes where soil is shallow and on the crests of hills, trees are well spaced and less (10-12 m) in height. Density and height increases down the slopes, and in the valley floor there is a sudden transition to deep marshes with swamp grass and thick bamboo clumps (*Bambusa arundinacea*) along the fringes. In area this type of forest is more extensive in the moist deciduous belt.

Benne reserve and Morgan betta area of Theppakkadu in Mudumalai sanctuary, Kudrakote, Padri, Kurichiyat (Narathi betta, Kalimala areas) and Nulpuzha reserves contain patches of evergreen or semi-evergreen forests. *Bambusa arundinacea* is profuse. *Hydnocarpus wightiana*, *Palaquium ellipticum*, *Artocarpus hirsuta* etc., are common.

Gregarious patches of evergreen *Shorea talura* occur in Theppakkadu, Doddakatti in Mudumalai, Chamanhalla area, parts of Beerambadi, Ainurmarigudi and Begur forests of Bandipur and Rampur and Mavanhalla reserves of Kerala.

In the more open forest there is a great preponderance of teak of a wide range of girth classes but *Terminalia tomentosa* is the key species. Soil is of great diversity and there is a lush undergrowth of grass, the height of which depends on closeness of canopy and soil moisture. It is up to 3 metres in open forest, consisting of *Cymbopogon* sp., *Themeda* sp. and *Imperata*. Where canopy is dense, instead of grass there is a mat of *Spatholobus roxburghii*. *Eupatorium* is prolific and *Dendrocalamus* is also common.

Where fire annually sweeps over the forest or where the soil is very shallow and the rainfall less, a retrograded type of the above forest type is met with where the canopy is very open, trees only sapling sized, 3-5 metres tall, and stunted. Mishappen gnarled teak and *Anogeissus* are profuse. There is a thick undergrowth of tall grass and *Phoenix humilis*.

The marshes or vayals are dotted with *Randia uliginosa*, *Butea monosperma*, stunted *Terminalia tomentosa*, *Careya arborea*, *Zizyphus xylopyrus* etc.

(2) **Dry Deciduous :**

The greater part of Bandipur core area is of this type. The rainfall is low and soil rocky. Canopy is open and 6-12 m high. Tree species include

Anogeissus latifolia
Terminalia tomentosa
Terminalia bellerica
Terminalia chebula
Terminalia paniculata
Gmelina arborea
Albizzia odoratissima
Schleichera trijuga
Stereospermum chelonides
Tectona grandis
Pterocarpus marsupium
Dalbergia latifolia
Grewia tiliaefolia
Salmalia malabarica
Dalbergia paniculata
Careya arborea
Odina wodier
Butea monosperma
Stereospermum xylocarpum
Lagerstroemia parviflora
Phyllanthus emblica
Gardenia sp.

The second storey consists of :—

Vangueria spinosa
Wrightia tinctoria
Zizyphus jujuba
Zizyphus xylocarpus
Bridelia retusa
Cassia fistula
Xeromphis spinosa
Xeromphis uliginosa
Santalum album
Kydia calycina
Shorea talura

The undergrowth consists of grasses, *Lantana*, *Eupatorium*, *Phoenix humilis*, *Helicteres isora*, *Desmodium* sp., *Curcuma* etc. (Photograph 2).

(3) **Scrub :**

This is typical of Sigur plateau (Moyar Reserve forest of Mudumalai sanctuary and Moyar state forest of Bandipur sanctuary). The rainfall is very low, soil rocky and is poor in humus. The vegetation is open deciduous scrub or even thorn forest of scattered bushes of no economic value. Sandal occurs sporadically. There are few gregarious patches of evergreen *Hardwickia binata* near Moyar.

TREES

Anogeissus latifolia
Albizzia amara
Derris glabra
Canthium didymum
Elaeodendron glaucum
Atlanta monophylla
Ficus sp.
Cassia fistula
Chloroxylon swietenia
Cordia sp.
Acacia leucophloea
Stereospermum chelonoides
Acacia sundra
Erythroxylon monogynum
Bridelia retusa
Dalbergia paniculata
Santalum album
Zizyphus jujuba
Diospyros montana
Zizyphus xylopyrus
Bauhinia racemosa
Azadirachta indica
Acacia catechu
Shorea talura

The undergrowth consists of :—

Opuntia dillenii
Sentia indica
Toddalia aculeata
Pterolobium indicum
Webera corymbosa
Cipadessa fruticosa
Solanum sp.
Grewia asiatica
Gymnosporia montana
Cassia tora
Cassia auriculata
Argyreia cuneata
Wendlandia notoniana
Clausena wildenovii
Desmodium sp.
Dendrocalamus (sporadic)

This area is subject to very heavy grazing and fire effect.

(4) **Plantations :**

Extensive plantations of teak and species of *Eucalyptus* occur over the entire tract. Plantations are relatively insignificant in the Mudumalai and Bandipur proper area, but occur over large areas of Begur, Kudrakote, Kuppadi, Kurichiyat, Mavanhalla and Rampur Reserve Forests in Wynad in Kerala, of Kalkere and Begur Reserve Forests in Bandipur National Park and Nagarhole Reserve Forest in Nagarhole National Park in Karnataka. Areas of Bandipur and Nagarhole also have thakkal plantations, which are sites of slash and burn cultivation planted with teak in the second half of last century and the first quarter of this century. The thakkal plantations are often indistinguishable from the surrounding indigenous forest, but the larger plantations are not. They are often susceptible to invasion by *Lantana* and *Eupatorium*, and if unsuccessful by weedy tree species such as *Kydia calycina*. The

plantation areas tend to be sterile from the view point of wildlife.

VI. Elephant

The major focus of the present survey was on the elephant, and every attempt was made to gauge the population density and the distribution of this animal. This attempt is fraught with many difficulties, and the methodology described above probably failed to surmount the various problems completely. Table 1 shows the details of the elephant tracks and actual sightings encountered during the course of this survey. We have undoubtedly missed some herds and doubly counted others. This

Table 1

The location and numbers of elephants seen at various localities during the survey and the data from the elephant tracks observed

Area and date	Tracks and numbers (approximate)	Sightings
Bandipur core area 15-7-75 to 25-7-75	Two group tracks (M)*	3 aggregation totalling 22, 19 and 28 animals each
Benne 28-7-75 to 29-7-75	Two group tracks (L)* One lone tusker track	One group of 4 Group of 8
Mudumalai 30-7-75 to 2-8-75	Two group tracks (L) one group track (M)	Group of about 24 lone tusker
Kargudi 3-8-75 to 4-8-75	Two lone tusker tracks one group track (L)	two lone tuskers
Theppakkadu 5-8-75 to 6-8-75	One group track (L) one group track (S)*	Makhna Group of 8 Group of 6 Group of 5 Pair of elephants two lone tuskers
Masingudi 7-8-75 to 8-8-75	Group track (M) 3 lone tusker tracks	
Chamanhalla 16-8-75 to 17-8-75	Lone tusker track Group track (M)	A pair of elephants Group of 10
Maddur 18-8-75 to 19-8-75	Lone tusker track Group track (M) two group tracks (S) two group tracks (L)	
Mulehole 20-8-75 to 21-8-75	One lone tusker track two herd tracks (M)	

Area and date	Tracks and numbers (approximate)	Sightings
Rampur 22-8-75 to 25-8-75	two group tracks (S) two group tracks (L) four group tracks (M)	Group of 18 Group of 16 Group of 11 Group of 20 Group of 30 1 lone tusker
Chickbargy 26-8-75 to 28-8-75	3 lone tusker tracks 2 group tracks (L) 4 group tracks (M) 1 group track (S)	1 group of 9 group of 22 group of 5
Moleyur 29-8-75 to 30-8-75	3 lone tusker tracks 1 group track (M) 2 group tracks (L) 2 group tracks (S)	2 lone tuskers group of 11 group of 5
Kalkere 31-8-75 to 4-9-75	2 Group tracks (M) 2 group tracks (S)	Group of 6 Group of 5 Group of about 15 Group of 18 Group of 13
Chowdahalli 5-9-75	4 group tracks (M)	Group of 9 lone tusker
Bannurgadde 6-9-75	1 Group track (M) 5 lone tusker tracks 2 group tracks (L)	Group of 16
Gundre 7-9-75	Group track (L) 3 lone tusker tracks	Group of 6 Group of 3 Group of 7 Group of 7
Byrankuppe 9-9-75 to 10-9-75	8 lone tusker tracks Group track (M)	One lone tusker pair of elephants Group of 8 Group of 8 Group of 10
Kaimara 11-9-75 to 12-9-75	2 Group tracks (S) 4 group tracks (L) 3 group tracks (M) 4 lone tusker tracks	Group of 4 Group of 6 Group of about 16
Sunkadkatte 13-9-75 to 15-9-75	3 lone tusker tracks 4 group tracks (M) 1 group track (L) 1 group track (S)	Group of 18 Group of 19 Group of 15 Group of 25 Lone tusker

* Group track (S)—Small, about 5 animals.
Group track (M)—Medium, 5 to 20 animals.
Group track (L)—Large, more than 20 animals.

Area and date	Tracks and numbers (approximate)	Sightings
Mettukuppe 15-9-75 to 16-9-75	Group track (M) 3 lone tusker tracks	2 lone tuskers pair of elephants Group of 9 Group of 6
Murkal 17-9-75 to 19-9-75	8 lone tusker tracks 3 group tracks (M) 1 group track (L) Track of a pair of elephants	3 lone tuskers Group of 4 Group of 11
Nagarhole 20-9-75 and 22-9-75	2 Group tracks (M) 1 Group track (L) 5 Group tracks (S) 3 lone tusker tracks	Group of 8 Lone tusker
Tittimathi 21-9-75	1 Group track (M) 3 lone tusker tracks	
Tholpetti 27-9-75	3 lone tusker tracks 1 group track (M)	
Chedleth 30-9-75 to 2-10-75	4 lone tusker tracks Group track (M) Group track (S)	Lone tusker
Muthanga 3-10-75 to 9-10-75	Group track (L) 2 group tracks (M) 3 group tracks (S) 3 lone tusker tracks	

data however does seem to indicate that the number of elephants in the area is not insubstantial, and may be somewhere in the vicinity of 1,500 animals, though this is just an educated guess.

Several interesting features emerge from the data presented in Table 1. The greatest concentrations of elephants were met within the Bandipur core area, Rampur, Kalkere, Sunkadkatte, Gundre and Begur (along Kabini) and Nagarhole core area. Smaller concentrations occurred in Theppakkadu area of Mudumalai and in Benne reserve. The entire Kerala Wynad was almost devoid of elephants (see figure 3).

The very noticeable disparity in distribution, with few animals recorded from the heavy rainfall Coorg and Wynad areas, and with a heavy concentration in the dry deciduous forests of Bandipur and along Kabini suggest local seasonal migrations. (Photographs 3 and 4.) Observations reported by the local foresters and tribals suggest that the elephant tends to move out of the wetter parts of the sanctuary complex during the monsoon season into the drier forests of the Mysore plateau. The heavy rainfall, rank vegetation, tall grass, slushy ground, the abundance of blood sucking insects and leeches as well as the normal reproductive cycle of the animal may have a role to play in favouring the animals leaving the wetter Wynad forests during the monsoon season. The movement also appears to be correlated with the ripening of crops in the drier parts. The

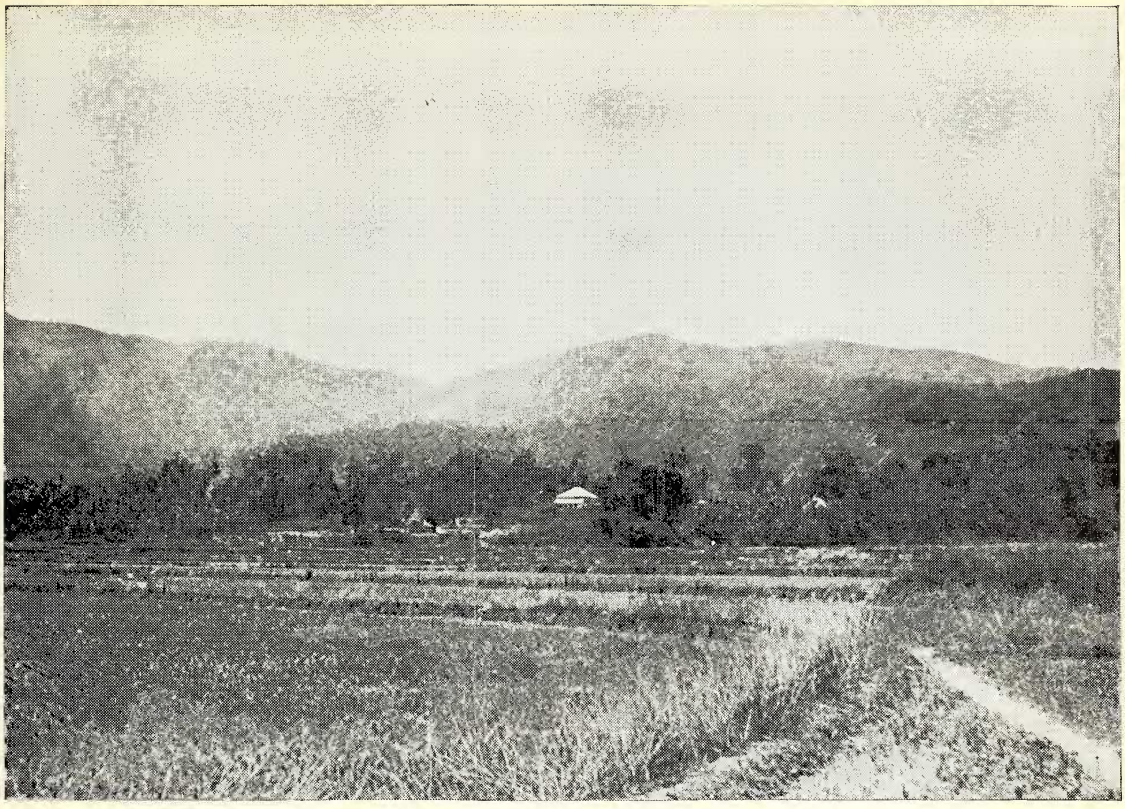

Photo 1. View of Brahmagiris in the Coorg Wynad.
(*Photo*: *Sharatchandra*)

Photo 2. Dry deciduous forest of Bandipur, a typical elephant habitat.
(*Photo*: *Sharatchandra*)

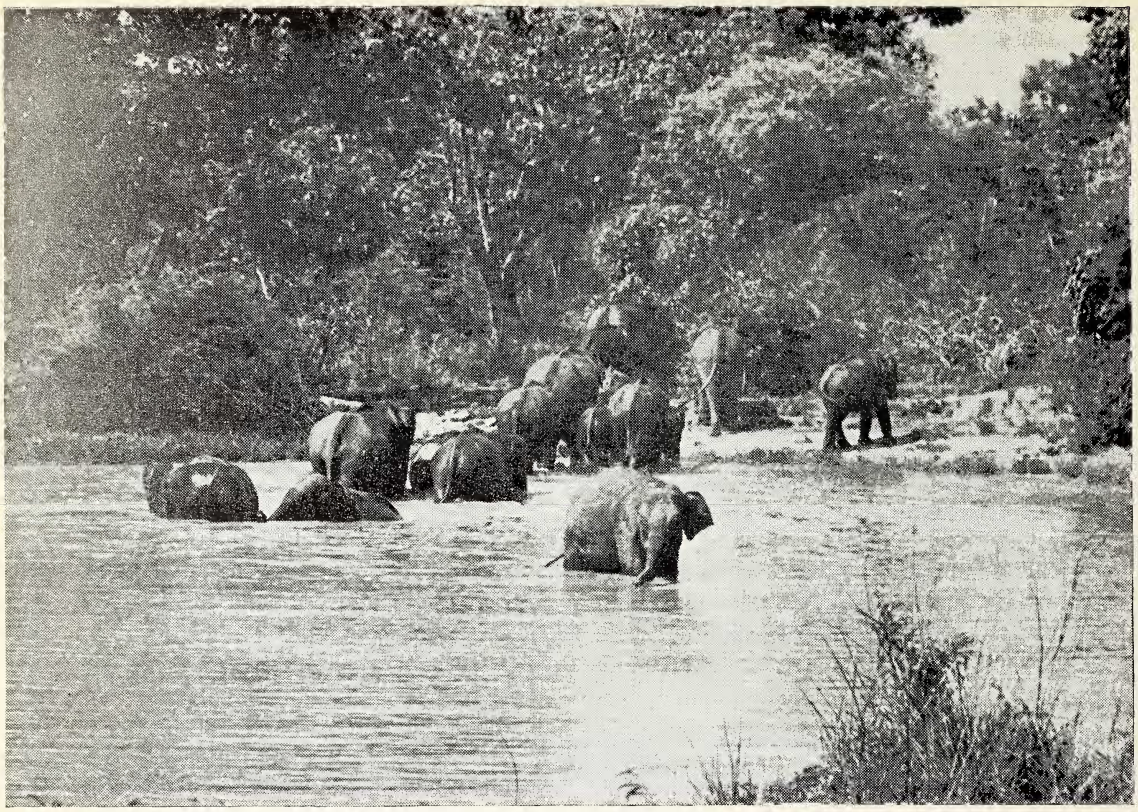

Photo 3. A herd of elephants leaving the Nanjanapura Pond at Bandipur national park.
(*Photo* : *Sharatchandra*)

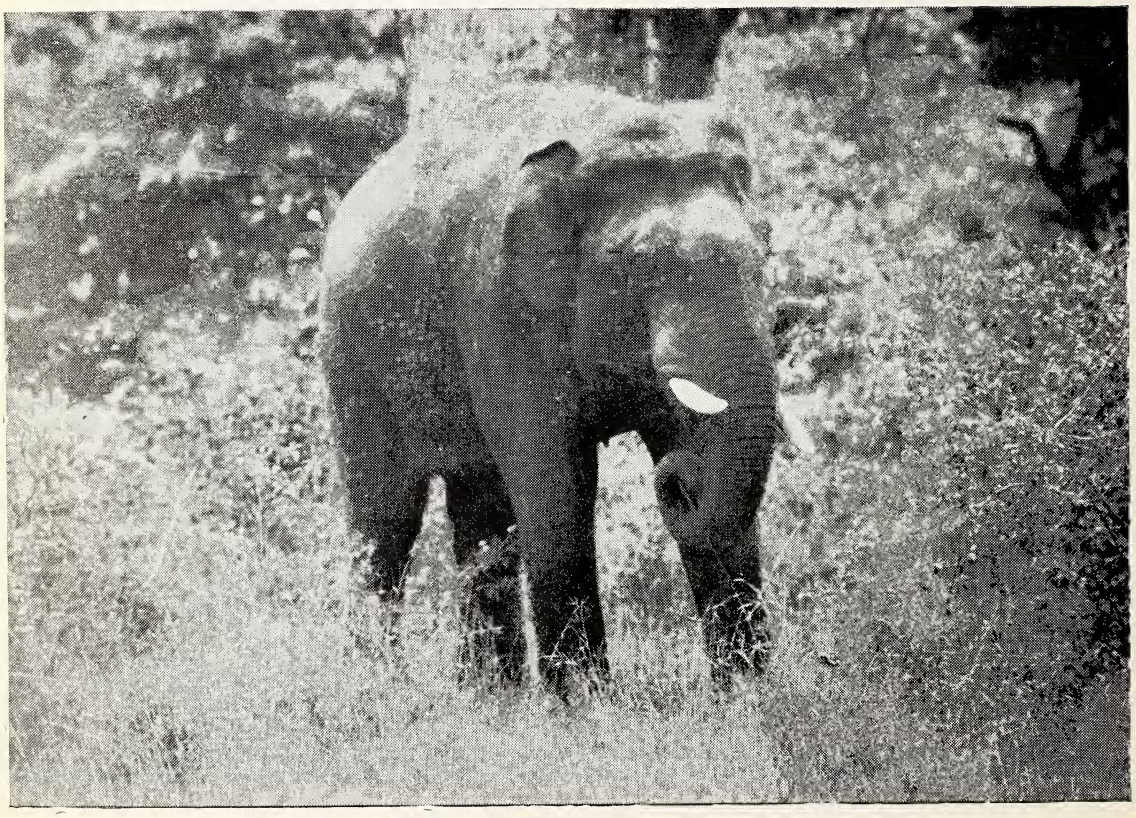

Photo 4. A solitary tusker.
(*Photo* : *Sharatchandra*)

Photo 5. A mouse deer.
(*Photo*: *Sharatchandra*)

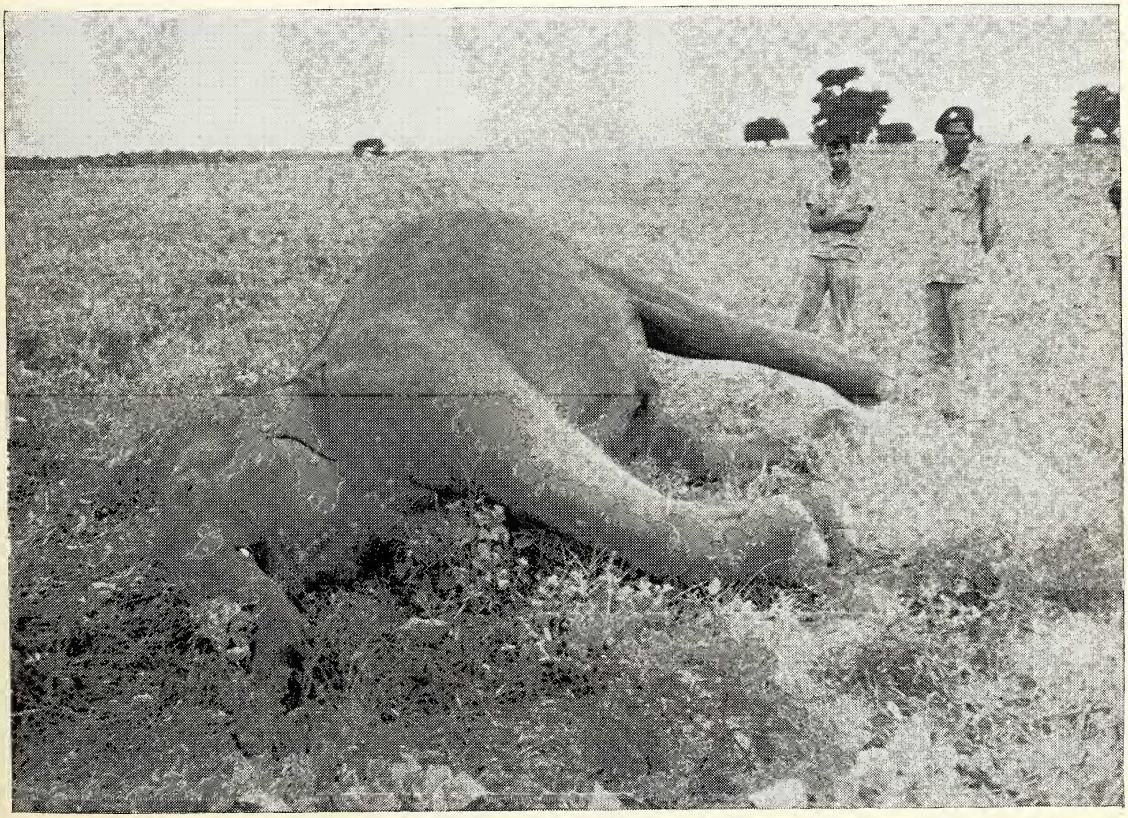

Photo 6. A cow elephant shot while raiding crops.
(*Photo*: *Sharatchandra*)

Photo 7. A chital killed by a fast moving vehicle on the Mysore-Ooty highway.
(*Photo : Sharatchandra*)

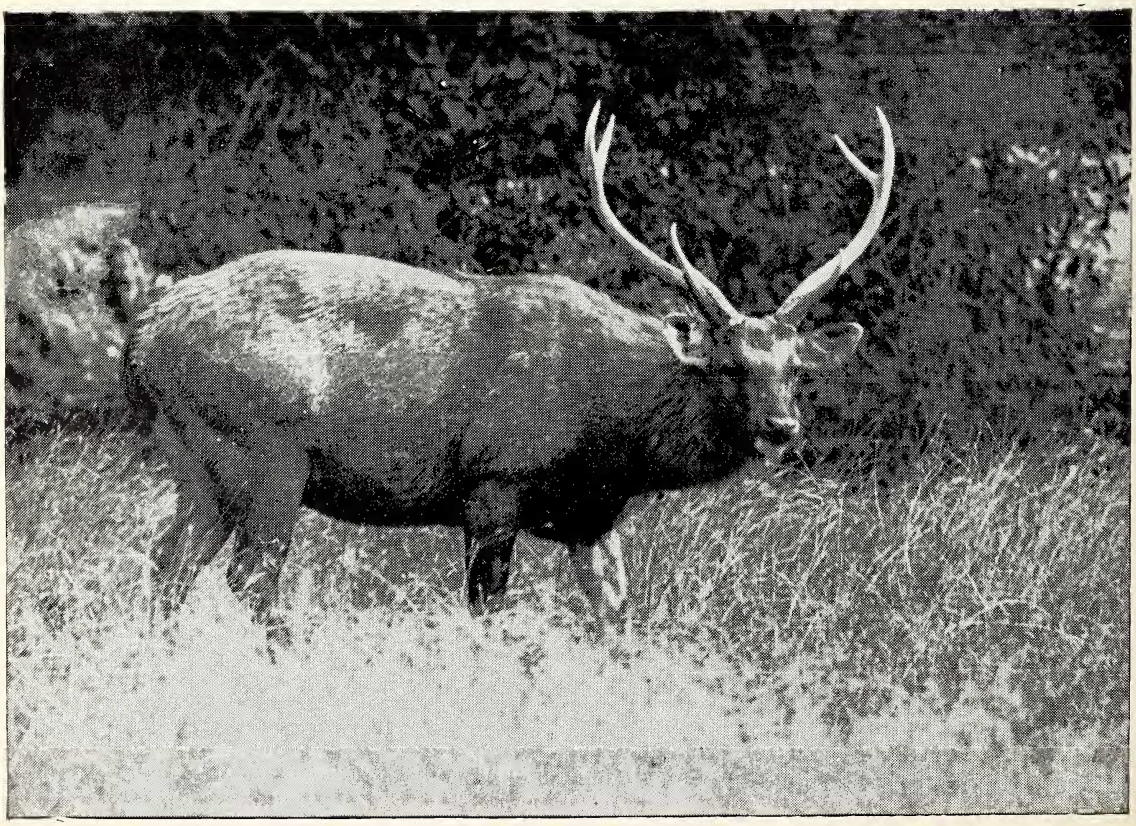

Photo 8. A sambar stag.
(*Photo : Sharatchandra*)

Photo 9. A herd of village cattle deep inside the sanctuary.
(*Photo : Sharatchandra*)

Photo 10. Kadukuruba tribals digging out *Dioscorea* tubers.
(*Photo : Sharatchandra*)

elephants were in fact congregated on the boundaries of the cultivation in many localities, particularly near Rampur—Kalkere and Chowdahalli. The fact that in these very same areas the buffer zones between the reserve forests and farm land provided by revenue forests are being removed is notable.

Migrations of elephants were probably much more extensive in the past than they are now. During the course of the survey, we came across a number of places where the traditional routes of the elephants are now in the process of being severed. For example, at Chick Bargi in Bandipur National Park, part of a migration route lying between two hills passes through a low lying area which has recently been put under cultivation. Elephants continue to move through these fields in their passage. Many other migration routes must have been cut off, and the elephants totally prevented access to them.

During the course of these movements, elephants presumably spend the drier months in the wetter forests of Coorg, Kerala and Nilgiri Wynads, this part of their range having a much better supply of fodder and water during the dry months. This summer range of elephants has been much disturbed particularly in the Kerala Wynad region, by the raising of plantations, and encroachment for cultivation. The Coorg Wynad is also subject, though to a lesser degree, to these activities. This must have resulted in a serious depletion of fodder in the summer range, and is likely to result in the degradation of the habitat by the consequent overgrazing by these animals.

The near total lack of elephants in Kerala Wynad is particularly striking. It is no doubt partly due to emigration from this area during the monsoons. However it must also to some extent be due to the tremendous scale of disturbance in those forests. In particular the destruction of the 25,000 acre of tract of Pulpally forest must be the reason for the very high densities of elephants in the Gundre-Begur area of Bandipur National Park.

Finally, though our inexperienced team blundered into unsuspecting herds of elephants scores of times, often at very close quarters, there was no instance of an elephant chasing us intruders. It was always the discrete withdrawal or precipitous flight on the part of the pachyderms. This no doubt goes a long way in identifying those guilty for the elephant's present sad plight.

VII. Other Wildlife

Though the primary purpose of the survey was to obtain data on the spatial distribution pattern of the Indian Elephant, data on flora and fauna was also collected to have a superficial picture of the plant and animal communities of the sanctuary complex. Though no attempt was made to estimate the population of the major animals other than the elephant, locations of concentration of species based on frequency of sightings and spoor evidence was collected. Since the survey party traversed the terrain following no fixed route covering a compact area as intensively as possible, it is expected that a rough indication of the distribution of the reported animals was obtained for the particular time of the year. For a picture of the wildlife concentration points in the survey area see fig. 4.

(1) **Gaur** (*Bos gaurus*) :

In the survey area this large herbivorous species ranges from scrub forest to semi-evergreen forest but seems to prefer undulating hilly terrain with moist deciduous vegetation and moderate undergrowth. Till the 1968 population crash due to rinderpest this species was very common over most of this tract but now the largest remaining aggregation is in the

Nagarhole sanctuary core area. A good population also exists in the Kalkere area of Bandipur National Park. Very small populations occur in Mudumalai, mostly in the Morganbetta area near Theppakkadu and few stragglers in Masingudi, Kekkanhalla and Benne areas of Mudumalai sanctuary. Begur forest of Kerala Wynad also has a small population and stragglers are present in southeast part of Bandipur core area. In addition to the considerable number of gaur in Nagarhole core, Sunkadkatte-Bisalwadikere area of Nagarhole sanctuary also has a good population.

Predation must be restricted mostly to calves. But poaching, though slight because of the restricted distribution at present, does exist. Since the flesh of a full grown animal would fetch a considerable sum, poachers from Kerala Wynad are reported to kill animals in Nagarhole sanctuary and Kalkere area.

Once the population builds up, the threat of communicable diseases like rinderpest would be greater. Though innoculation and checking of cattle exists along most of the interstate routes, preventive measures in local villages and forest settlements are inadequate. The recent gaur deaths in Periyar sanctuary point to the need for constant alertness.

(2) **Sambar** (*Cervus unicolor*) :

Sambar normally prefers broken terrain with thick undergrowth. But they were repeatedly encountered even in the very open scrub of Moyar forest of Mudumalai. The population in the sanctuary complex is subject to predation by most of the larger carnivores and poaching also takes a heavy toll. Though compared with spotted deer they were infrequently encountered, they are distributed over the entire survey area and considerable numbers exist in the Nagarhole core area, Kalkere area of Bandipur and also along the northeastern portions Begur, Kurichiyat, Rampur and Mavanhalla reserves. (Photograph 8.)

(3) **Chital** or **spotted deer** (*Axis axis*) :

This is the most significant prey animal in this tract. It favours plains with rather open vegetation and has the tendency to congregate around human habitations. Very large congregations of this species occur in the Masingudi area of Mudumalai, Bandipur park headquarters area and Nagarhole core area. Opening up of forests by man for plantation activity is helpful to this animal. Their considerable number, gregarious habit and tendency to favour open forest result in heavy poaching. In Bandipur park headquarters area domestic dogs have developed the habit of killing the fawn and immature animals. The largest single aggregation seen during day time numbered over 150 animals in Moyar forest of Mudumalai. (Photograph 7).

(4) **Wildboar** (*Sus scrofa*) :

Together with Chital, wild pig forms the most plentiful prey animal. It is extremely adaptive and occurs in every type of terrain and survives the very heavy poaching pressure in parts of Wynad. The impenetrable thickets that smother cleared land afford shelter and hence the intrusion of *Eupatorium* and *Lantana* should have favoured this animal. They are most numerous in the marshlands with soft soil and succulent vegetation. Due to their frequent occurrence in degraded forests around cultivations from where they regularly raid the crops, conflict with man is frequent and poaching of this species is perhaps heaviest. A single party of 18 animals with 9 piglets from two litters numbering 5 and 4 was encountered in the Nagarhole sanctuary at Hasihindalkadalu near Mettukuppe.

(5) **Four horned antelope** (*Tetracerus quadricornis*) :

This animal is very rare and in the entire sanctuary complex reliable reports suggest its

occurrence only in the Sunkadkatte-Bisalwadikere area and the only animal actually seen was near Bisalwadikere, a very open savannah type of habitat. Obviously this interesting animal needs careful watching over to prevent any further reduction of the population.

(6) **Barking deer** (*Muntiacus muntjak*) :

This beautiful, elusive animal is possibly far more numerous than is apparent from sightings and track data since it frequents thick undergrowth, is solitary and is extremely wary. Because of these very same reasons poaching of it might not be heavy. This animal forms another important prey animal for the larger carnivores.

(7) **Mouse deer** (*Tragulus meminna*) :

Like the barking deer the Indian chevrotain or mouse deer also occurs over the entire tract in considerable numbers as was evident from the track data. It prefers very thick undergrowth hence is commonest in overgrown plantations. Trapping of this animal, especially by crush traps must be heavy along the periphery of the forest, for example, in the Beerambadi-Maddur area. (Photograph 5).

(8) **Blacknaped hare** (*Lepus nigricollis nigricollis*) :

Grasslands and open forests, even glades in the thicker forests constitute the habitat of this common animal. They survive in very degraded forests along the edges of cultivation and hence get heavily trapped or otherwise poached. It must also form a major food item for most carnivorous mammals and birds.

(9) **Tiger** (*Panthera tigris*) :

Based on track evidence, tiger seems to occur widely in the sanctuary complex with no specific preference for particular habitat type. They seem to frequent the following areas : Doddakatti, Kargudi, Kekkanhalla, Bandipur core area, Kalkere, Rampur, Bannurgadde, Kaimara, Bisalwadikere-Sunkadkatte, Nagarhole core area and Dasankatte area of Kerala Begur. In Nagarhole sanctuary near Mettukuppe between Madamahalli cart track and Mathanahallikkadu on Nagarhole stream, extremely frequent movement of more than one tiger and also of leopards was noted. Conflict with cattle graziers (who might then attempt to poison tigers) could adversely affect this totally protected species. Bandipur National Park being a project tiger area, is primarily conceived as a tiger reserve and the official estimate of the tigers within this reserve is about 19 animals. The only animal encountered during the survey was in the Begur forest of Kerala Wynad.

(10) **Leopard** or **Panther** (*Panthera pardus*) :

This perfectly camouflaged, highly adaptive carnivore occurs not very rarely over most of the survey area but seems to occur most commonly in the overgrazed degraded forests. Most of the cattle lost to carnivores could be attributed to it. Leopard is the sole predator of the larger arboreal mammals in this area. The pug marks were most frequent in the Moyar reserve of Mudumalai and in Nagarhole core area and also Sunkadkatte area. In addition, Morganbetta area and Kekkanhalla area of Mudumalai, Rampur-Kalkere area of Bandipur and adjacent parts of Kerala Wynad along the boundary (Rampur and Kurichiyat reserves) and also Begur reserve along Karnataka boundary appear to be their favoured haunts.

(11) **Sloth Bear** (*Melursus ursinus*) :

Sloth bears are widely distributed over most of the survey area especially in the more open drier forests. Their numbers apparently are highest in the Doddakatti area, Mudumalai camp area and around Masingudi in Mudumalai

sanctuary, Bandipur core area, the interstate border areas of Rampur, Mavanhalla reserves of Kerala Wynad and also Sunkadkatte-Mettukuppe areas of Nagarhole. Of the six occasions the animals were encountered, thrice it was in Rampur-Mavanhalla reserves of Wynad (once a pair), once in the Begur reserve, once in Kurichiyat and once in Nagarhole sanctuary core.

(12) **Dhole** or **Wild Dog** (*Cuon alpinus*) :

Over most of the sanctuary complex wild dog appears to be plentiful which may perhaps be an exaggerated impression due to their high mobility. This pack hunter was most frequently encountered in Mudumalai camp area, Masingudi and Theppakkadu of Mudumalai sanctuary, Kaimara area of Bandipur, over most of the Nagarhole sanctuary especially Sunkadkatte area and Begur forest of Kerala near Karnataka boundary. They were not at all seen in the remaining portions of Kerala Wynad.

In the characteristic human way, this carnivore is branded a 'vermin' and is killed indiscriminately, especially since it has no trophy value either.

(13) **Jackal** (*Canis aureus*) :

Jackals prefer open scrub and degraded forests near human habitations and are apparently infrequent in most of the sanctuary area. The only animals encountered were a pair near Masingudi in Mudumalai. They are not infrequent in parts of Kerala Wynad.

One member of the survey party and a forest departmental staff saw an animal in Kattikulam reserve forest which could be the Indian fox (*Vulpes bengalensis*).

(14) **Striped Hyena** (*Hyaena hyaena*) :

Hyena is reported to occur in the scrub forests around Masingudi though none were seen.

(15) **Hanuman langur** (*Presbytis entellus*) :

Hanuman langur occurs in fairly tall, canopied but rather open forest in most of the surveyed tract but the distribution is highly sporadic. They were most commonly seen over most of the Mudumalai sanctuary except Benne forest but occur in Moyar forest along the stream banks. They are fairly numerous in Bandipur sanctuary but very sporadic in most of the other areas. Along with one troop of Hanuman langur in Morganbetta area a black coloured animal—most probably a Nilgiri langur—was seen on two occasions and the same animal had been reported by local officials also. The animals were extremely shy in most of the areas outside Mudumalai.

(16) **Bonnet macaque** (*Macaca radiata*) :

Bonnet macaques are not very common within the sanctuary complex and occur mostly along the periphery, near human habitations. They were seen at Kargudi, Theppakkadu, Benne and Kekkanhalla area of Mudumalai, Bandipur, Maddur and Mulehole areas of Bandipur national park and Muthanga area of Wynad, everywhere near settlements. Troops were also seen deep inside the forest in Kaimara-Rampur areas and in Mavanhalla reserve.

(17) **Giant squirrel** (*Ratufa indica*) :

This occurs throughout moist deciduous and semievergreen habitat in the survey area but in more open forest is very rare or absent. The largest numbers were encountered in Mudumalai sanctuary excepting Moyar reserve. Nagarhole sanctuary and undisturbed forests of Kerala Wynad also have fairly good populations. Poaching pressure on this animal is not very heavy.

(18) **Peafowl** (*Pavo cristatus*) :

Peafowl occurs over most of the surveyed area but heavy poaching and trapping has

reduced the population considerably in most of the area. It apparently prefers scrub and deciduous forest. Concentrations of peafowl within the sanctuary complex are in Masingudi area, Theppakkadu, Bandipur core area, Chickbargi, Sunkadkatte, Nagarhole sanctuary core area and border areas of Kerala Wynad in Begur, Kurichiyat and Rampur reserves.

(19) **Crocodile** (*Crocodylus palustris*) :

Together with the carnivores, this reptile has been persecuted by man heavily and has been almost wiped out in most of its previous haunts. Any undisturbed stream with deep pools and adequate prey is potential crocodile habitat. It might have existed all along Kabini, Nugu, Lakshmantirtha, Panamaram puzha, Nulpuzha, Mannantoddy puzha and Moyar but it was encountered within the survey area only in the Kuruva Island reserve in North Wynad. This reserve does not actually come within the sanctuary limits. Reliable information is available on the existence of crocodiles in Nugu. Two animals were seen in Kuruva. Though this highly endangered species is given total protection by wildlife act, actually it is receiving little protection. Poaching does take place in Kabini. Since the small population of crocodiles existing within the sanctuary complex is distributed along the river downstream from Kuruva amidst the large number of small islands, with encroached Pulpalli lands on one side and cultivated revenue lands on the other at least in part of the area, poaching is hard to control. At least one instance of crocodile meat openly put for sale from a poached animal occurred in 1974.

(20) **Species introduction :**

Introduction of animals by man into a habitat where they never occurred previously, is generally harmful to the concerned ecosystems and is not a recommendable step. But reintroduction of species into habitat wherefrom they were wiped out should be an essential conservational measure. The reintroduction of three species of threatened animals into this sanctuary complex should be contemplated.

(i) Blackbuck (*Antilope cervicapra*) :

This plains dwelling herbivore, the only Indian antelope, was widely distributed over the entire Deccan plateau including part of the present-day sanctuary complex but is so greatly reduced that the only large population in south India is in the Point Calimere sanctuary, Tamil Nadu. The habitat of this animal is comparable to that of Masingudi area—Moyar, Averahalla and parts of Kalmalai Reserve. If the cattle grazing is restricted in this area it could form an ideal Blackbuck habitat enriching the fauna of the sanctuary and providing an alternate breeding nucleus of Blackbuck.

(ii) Nilgiri tahr (*Hemitragus hylocrius*) :

The ' mountain goat ' of the Western Ghats is another threatened species of herbivore that could be reintroduced into its former haunts. The Brahmagiri range was tahr habitat till recent times and records of tahr sightings in the Periyar reserve of Kerala, not far removed, date as recent as the early 1960's. The Brahmagiri sanctuary and its western Kerala slopes should form a composite protected area connected with this complex and tahr could be reintroduced here. Tahr at present survives in adequate numbers only in the Nilgiri escarpments and the Eravikulam area of Kerala High ranges.

(iii) Primates :

This sanctuary could also become a haven for the Nilgiri langur (*Presbytis johni*) and perhaps the liontailed macaque (*Macaca silenus*). As no detailed survey of the Brahmagiri sanctuary nor the western slopes in Kerala were

conducted, first hand information on the distribution of these species is not available but local information suggests the total wiping out of these two animals there.

VIII. Conservation

(1) Maintenance of habitat integrity :

No part of a self-perpetuating natural ecosystem could be preserved for any length of time in isolation. It has to be conserved as a natural unit irrespective of administrative or political boundaries. Wild elephants cannot be preserved independently of their habitat. To maintain a genetically viable population of a large, highly mobile, gregarious, herbivorous species like the elephant in an area where the availability of forage and water are prone to drastic seasonal fluctuations, a significantly large undisturbed area must be left aside. More than direct poaching, the most serious threat to this population of elephants is the alarmingly rapid and continuing fragmentation of its habitat due to a variety of reasons ranging from deforestation, extension of plantations, agriculture, dams and other construction activity (see fig. 3).

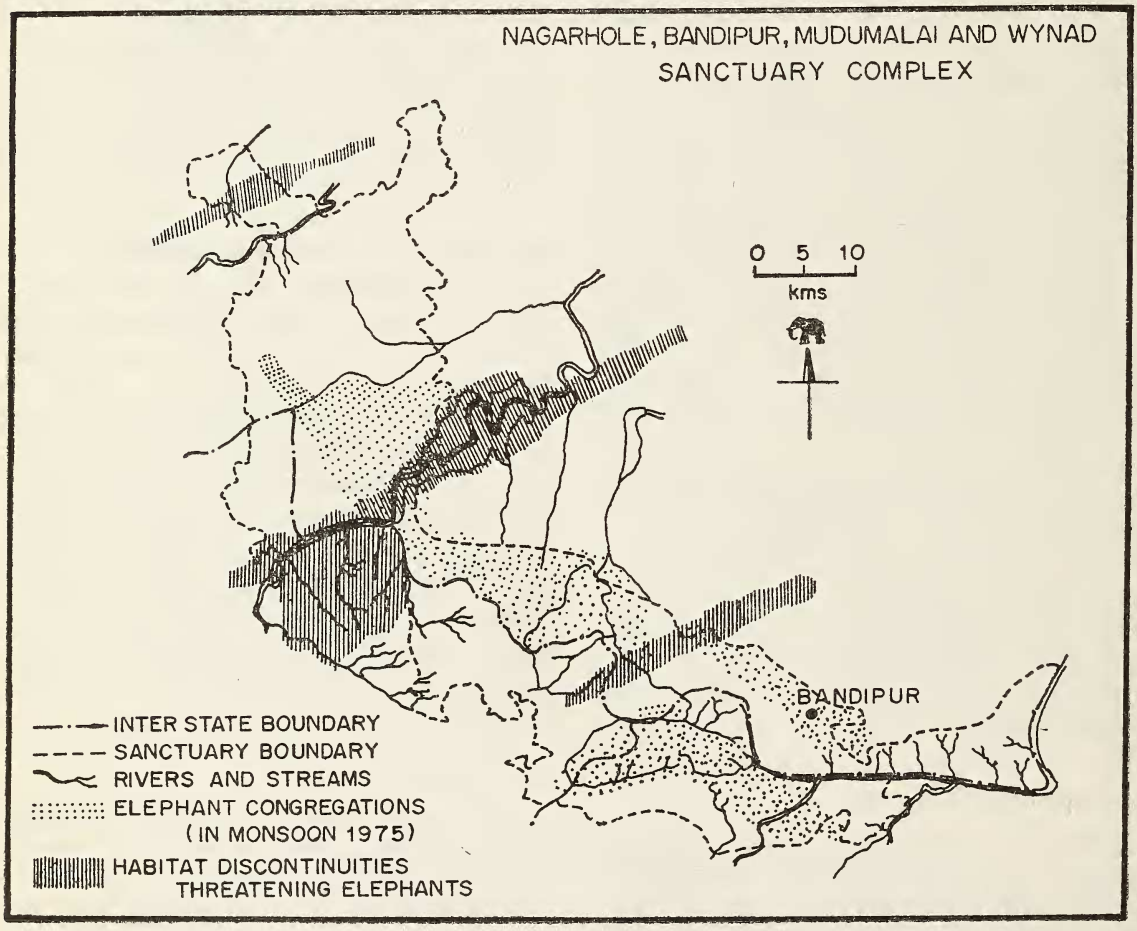

Fig. 3. Elephant concentrations and habitat discontinuities in the proposed Jawahar National Park.

In this sanctuary complex, the carrying capacity of the habitat is low in summer except in the Nagarhole core area, along Kabini (Kakankote and Begur Reserve Forests), along Moyar in Mudumalai forest and in Benne Reserve Forest as well as the whole of Kerala Wynad where plantations have not extended destroying cover and forage. From the food and water availability in Kerala Wynad this area seems vital for the elephants in the survey area in summer. Forest officials and local information confirms the annual summer influx of elephants into Wynad but unfortunately poaching and habitat destruction are severest here. In the entire Wynad wildlife sanctuary of Kerala, the only sufficiently large areas with natural forests that can support elephants are in the Northeastern portions of Begur, Kurichiyat, Mavanhalla and Rampur Reserve Forests. All the remaining areas are pock-marked by plantations and cultivations. Further reduction of forests here would certainly adversely affect this elephant population south of Kabini.

For the continuity of this elephant habitat and for the integrity of the population of elephants, the most serious and immediate threat is the Kabini project, the impounded waters of which meeting with the Pulpally encroachments in Kerala, threaten to cut this population into two distinct halves. On the south bank of Kabini in Kerala, opposite the Kakankote forest of Karnataka, the Pulpally forests along the river for a length of 8-13 kilometres, encompassing an area of about 25,000 acres have been encroached upon and clear felled during the last one decade. Further north along Kabini, the reservoir waters would be too wide for the elephants to cross from one bank to the other.

Near Baveli, in Karnataka along the Kerala State Border, forests are being clear felled for plantations which will further hinder movement of elephants from one state to the other. Those that do move into the Begur Reserve Forest of Kerala from Karnataka forests will not be able to move into any other forest to the south in Kerala, since beyond Padiri Reserve Forest (which is outside the sanctuary), the Pulpally encroached lands rule out the movement of all animals. To the west from Begur Reserve Forest the Kudrakote Reserve Forest is so greatly altered that elephants will not find it easy to pass on to the north—the Thirunelli area.

In Karnataka along Kabini on the eastern side, in the Gundre-Begur area, elephants congregate in summer from adjacent drier Mysore Plateau forests. These forests are the prime haunts of elephants but besides the large tract submerged by the Kabini reservoir, vast areas are being cleared for resettling people evacuated from the cultivated lands submerged due to the project. Forests around the once famous Kharapur have given place to hard baked fields, the same ' development ' is taking place in Begur and Gundre.

The Tittimathi forests and Kachuvanchalli forests, north of Lakshmantirtha river is yet another area famous in the olden days for wild elephants where they now face severe pressure. The Hadlu cultivators (encroachers cultivating the wetlands in these forests) denying the use of the marshy areas to the animals and the disturbances caused by these people have rendered these areas almost devoid of wild-life. Poaching even of elephants is also reported.

In Bandipur national park, an area of severe pressure on the elephants and its habitat is along the Gundlupet—Sultan's Battery road, from Beerambadi—Maddur to Mulehole. The revenue forests along the reserve boundary in this area, which had acted as a buffer for so long, are all being cleared. Unless habitat degradation is arrested in this area immediately, this would become a bottleneck restricting free movement of the animals across.

The position in Kerala Wynad is by far the most alarming. Already the sanctuary part is in two isolated halves with cultivation in between. In the northern half, the Kudrakote Reserve Forest (west of Mannantoddy—Mercara road) originally of rich moist deciduous vegetation with plenty of available water has been extensively clear felled for plantations rendering it practically non-usable by elephants. Further south, the small Edakode Reserve Forest and Kattikulam Reserve Forest, south of the Kattikulam-Baveli Road are ringed in by cultivations.

In the southern half, the Kuppadi Reserve Forest is practically cut off from all other forests to the west by cultivations. There are two slender links between Kuppadi Reserve and Kurichiyat Reserve, one through Malappadi west of Chedleth Rest house and another between 3rd and 5th miles along S. Battery—Chedleth Road, which might permit elephants to enter. The reserve is heavily grazed, disturbed and elephant poaching cases in recent years are many. Kallur Reserve, Alathur Reserve and Edathori Reserve are small reserves with cultivation all around.

Mavanhalla, Rampur and Kurichiyat reserves are large in extent but even here extensive plantation activity is going on. Even the narrow belt of natural vegetation along the interstate boundary is heavily grazed except in a few localities and poaching appears to be very common. The entire western boundary of Kurichiyat Reserve is subject to heavy human disturbances from the encroachers in the Pulpally area from which the reserve is separated only by a stream—the Kannegalhole or Kannaram puzha. The Neminad Reserve south of S. Battery—Gudalur Road is also isolated and reportedly plans are afoot for clear felling and planting the entire reserve.

In Mudumalai sanctuary, the southern edge of the Kumbarkolli Reserve where it faces Nilambur Kovilakam patta lands and also the extreme eastern portion near Moyar, Singara and Mavanhalla villages face very heavy grazing pressure. Poaching in the forest to the east outside the sanctuary to the Anaikatti area impede movement of elephants from Nilgiri escarpments to Masingudi area.

Though this sanctuary complex by Indian standards covers a large area of forest extensions are suggested to include adjacent habitat types harbouring endangered species not seen in the existing sanctuary area but where they had been exterminated recently and where they could be reintroduced successfully. Bringing under the protection of sanctuaries those corridors that provide links with other extensive forest tracts is essential to retain avenues for free movement of wildlife.

The present sanctuary complex does not have any west coast tropical evergreen forest within its confines. Brahmagiri sanctuary in Coorg has the evergreen shola-grassy down habitat so typical of Kerala high ranges and Nilgiris. Including this sanctuary and linking it up with the Nagarhole-Bandipur complex would enrich the variety of scenary and biota of the complex. While the Brahmagiri sanctuary is situated on the eastern slopes of the Brahmagiri range, the Thirunelli, Kambanmalai, Thrissileri, Kottiyoor forests cover the western slopes. These rich evergreen forests in Kerala should also be given protection by declaring them as a sanctuary especially so since they contain a small relict population of Nilgiri langur and harboured Nilgiri tahr till very recent times. On reintroduction, if protected, these species would thrive in the rolling grassy hillocks of the Brahmagiri range.

In the Kerala Wynad between the ravaged Kudrakote Reserve Forest and Coorg border, the Alathur Reserve (of Begur range) containing very rich bamboo forest should also be included in the sanctuary as it supports a good population of elephants. Ideally the entire

belt of forest along the Coorg Kerala border should become a protected area.

Kuruva Island reserve is another forest area highly recommended for inclusion within the sanctuary complex. This reserve besides being ecologically and floristically notable, harbours crocodiles too. The belt of forest including Kalmalai reserve linking the Mudumalai sanctuary with the Nilgiri escarpment forests should also be brought within the sanctuary to safeguard this corridor enabling unhindered movement for wildlife from Nilgiris right across the plateau to the western ghats.

(2) **Buffer Zones :**

The degradation and consequent destruction of forests by human activity is an insidious process most apparent along the forest edges where the intact biotope can be seen being nibbled away. Any forest ecosystem that is to be kept intact should have a peripheral buffer zone for absorbing the unavoidable human interference. But unfortunately, instead of creating buffer zones all around the outer perimeter of existing sanctuaries and reserves, the trend is to remove all existing buffer zones. This actually points to the lack of a co-ordinated national policy of land management and an integrated agency for directing and implementing it. The consequences are an irreversible deterioration of land, both forested and cultivated.

Conservation of any forest ecosystem depends vitally on the existence of a buffer zone around it to absorb the unavoidable human interference. Revenue forests, lying between the reserve forests and villages, everywhere used to serve this purpose. Release of these revenue forests for cultivation in many areas is bound to have a deleterious influence on the sanctuary.

In Bandipur National Park, along the western margin of Beerambadi forest, for example near Maddur, there was a belt of revenue forest, ecologically indistinguishable from the reserve forest. This entire belt of forest is being or has already been clear felled and handed over for cultivation. These forested areas formed a buffer zone between the village lands along the Gundlupet S. Battery road and the reserve forest, shielding the latter from the human exploitational pressure. In the process the revenue forests were overgrazed and overfelled. The same fate will befall the reserve forest now that the protective buffers are lost. The uncontrolled denudation of revenue lands in this particular tract will have far reaching detrimental ecological consequences. The reserve forests clothe the rocky, steep slopes of the Gopalswamibetta and its spur hills whereas the revenue forests are on the foothills and on the edge of the plains. Destroying the vegetation cover along the many rocky streams where they debouch from the steep hillsides will lead to destructive erosion and alter the hydrology of the farm lands in the plains. This is taking place in Moleyur area too.

In Kerala Wynad, the former private forests now vested with the Government, often lie adjoining the sanctuary and the reserve forests. The management of these vested forests is at present in no way compatible with the concept of protecting the adjoining sanctuary. The Kakkodan vested forest is an ideal but not an isolated example.

The tragic consequences of the lack of buffer zones on the adjoining reserve forests are very apparent in the Mudumalai sanctuary towards Thorapalli in compartments 20 and 6 facing the utterly devastated Nilambur Kovilakam patta lands. The forests are heavily overgrazed, lopped and poaching is heavy. The Pulpally encroachments, just a decade back sylvan forests, now stand as charred stumps and countless hutments. The spill-over ecological effects and inroads made by the expanding population here will have irreparable and costly effects on the reserves of Kuppadi,

Kurichiyat and Padiri and will affect the entire Wynad plateau.

(3) **Forestry operations :**

Interests of nature conservation and forest management for exploitation are not necessarily incompatible. It should certainly be possible to organize forestry operations in such a way that the wildlife interests are safeguarded without drastically reducing the sustained yield from the forest.

Certain core areas should be designated as sanctum sanctorum areas, and left totally untouched. These should be chosen so as to represent all the rich diversity of vegetation present in this sanctuary, and this diversity should be maintained intact. These sanctum areas will serve as the stores of genetic variability wherefrom the future generations can find or develop useful or even essential requisites. As far as possible, this indigenous vegetation should form a continuous belt of forest, as it is well known that a continuous piece of habitat is much more valuable for the maintenance of biotic diversity, than the same area fragmented into a number of habitat islands. As of today, all the Bandipur National Park is set aside for conservation without any forestry operations being allowed. Nevertheless, heavy human disturbances do affect many parts of that National Park also. The sanctum sanctorum area of Nagarhole is not free of forestry operations, and should be made so. There are no such sanctum areas in Mudumala or Wynad.

Selection felling could continue outside the sanctum sanctorum areas. Selection felling, on the whole does not disturb the habitat as much as clear felling, and is preferable to the latter practice within the sanctuary areas. Even here, provision should be made to leave a few of the large sized, overmature trees standing, as these furnish many important requisites for the wildlife, such as nest holes.

Plantation activity should be kept at a minimum within this sanctuary complex. The plantations of single species of trees are very sterile from the point of view of the biological community as a whole. They are also subject to invasion by *Lantana* and *Eupatorium*. The thick growth of these weeds is of little forestry or wildlife value. They choke out all tree saplings and other plants, and cause severe fires. *Eupatorium* is not touched by any birds or mammals—elephants avoid it like plague. The plantation areas are leased out for the so-called taungya cultivation for two to three years in Kerala and other places. These cultivators often cause great disturbance to the wildlife. There should be strict supervision to ensure that they are taking proper care of the plantation, checking fires in the plantation area, and not indulging in poaching.

Bamboo forms an important component of the vegetation throughout this sanctuary complex. Its shoots are relished by elephants and other wild animals. It also serves the function of holding soil on stream banks. Bamboo flowers gregariously, and the whole crop dies on flowering. Such gregarious flowering and mass death of bamboo clumps has occurred over much of the sanctuary complex during the past twelve years. It is a matter of grave concern that the bamboo crop has totally failed to re-establish itself over many areas following the last gregarious flowering, thus wiping out an important forest produce and source of nourishment for wildlife. Excessive exploitation, fires and overgrazing are the three major causes of this. Serious consideration should be given to checking all of these over the sanctuary complex in future.

Development is often equated with the construction of roads. But if the roads are through forests, it is often the beginning of the end for the forests. Roads accelerate degradation of forests directly and indirectly. Besides fragmenting the habitat, they provide

with equal impartiality access for woodcutters and poachers, cattle graziers and smugglers. The opened up canopy encourages the strangle growth of *Lantana* and *Eupatorium*.

The entire survey area has a lengthy network of forest departmental and public roads; in addition there is an extensive coup and bamboo extraction road network. These coup roads are always left intact honey-combing the entire forest, allowing the jeep and flashlight poachers and illegal woodcutters in bullock carts easy access. These roads should be rendered unserviceable as soon as the original purpose is served by cutting deep trenches across where they join the permanent roads.

Another ill conceived development of the last few years is the construction of unnecessary panchayat roads etc., cutting through forests. Many such roads were opened as part of drought relief programme often through forests just because land was free. The Moyar-Mavanhalla panchayat road and Nagampalli-Muthukuli road in Mudumalai, the H. D. Kote-Murkal new road through Hotgot forest in Nagarhole and Mettukuppe-Murkal road are some examples.

Private individuals are issued passes for the collection of dead firewood from many forest areas within the sanctuary complex. They are a source of great disturbance, and have a tendency to create dead wood by cutting down living trees. It would therefore be desirable if issuance of such passes is altogether cancelled, and the dead wood collected under departmental supervision and issued from the depots, just as the issue of licences for collecting bamboos for basket-weavers has been stopped.

(4) **Water Resource Development :**

A number of reservoirs have been constructed, or are under construction, or are proposed to be constructed throughout this sanctuary complex. There are in addition to the gigantic Kabini project in the heart of the area, the Nugu dam and Moyar power house along the periphery in Karnataka and Tamilnadu respectively. Though of a much smaller size, the Maruvakkandi dam in the Masingudi area of Mudumalai and the Taraka dam under construction near Mettukuppe in Nagarhole sacntuary have submerged and altered a considerable area of the habitat. A small dam is being built at Moolapura in Bandipur. Though now shelved, there was a proposal to construct a dam across Moyar in Theppakkadu area of Mudumalai sanctuary which would have completely destroyed the best part of Mudumalai forest. There are some projects under investigation in Wynad part of Kerala too.

The devastation brought about by the dam during construction activity and by the subsequent backing up waters is irreparable and extensive. The Kabini project alone has submerged or otherwise resulted in the destruction of the best part of Kakankote and Gundre-Bagur forests. The best part of the elephant habitat in the entire survey area is being destroyed by this project. In addition to the vast area inundated (5000 acres) still more extensive areas of forest has been deforested (10,000 acres) for resettlement of displaced people. Nisna Bagur spreads raw and barren over the hills, till so recently verdent woods. In this state with a comparatively low population density, other equally suitable lands could have been located for resettlement. 3,000 more acres are set aside for clearing in future. Moreover the resettlement done unscientifically will damage the project itself by accelerating silting up. For the elephants completion of the Kabini project, beside depriving them of the best part of their range, has also resulted in severing the population into two isolated halves. Because of this, the optimal density of elephants this tract can support will get reduced considerably especially in summer.

On the other hand effectively protected and developed along properly planned lines, these water bodies can enhance the recreational value of the habitat, create more variety of niches and by being the congregation points for wildlife in summer become focal points for tourists.

(5) **Cultivation :**

Enclaves of cultivated land in the otherwise extensive reserves are nothing exceptional in India but in this particular tract this kind of cultivation is most extensive. The entire Wynad plateau is dotted by marshlands most of which are occupied by cultivators. These lush moist nuclei of wildlife also control the stream flow over the entire tract. These marshes are usually interconnected, girding the gentle hills and most of the extensively used wildlife trails meander along their edges. Even those under cultivation but where poaching is not heavy remain foci of wildlife congregation (for example ' Kurichiyat vayal '). The list of major wildlife areas in the survey area given elsewhere attest to their importance. The more grassy open terrain dotted by thickets providing cover and plentiful water round the year must be the attractive features. In Kerala Wynad very few vayals remain uncultivated. Most of the accessible ones are cultivated mostly by encroachers and those deep within the forest are occupied by Chetties on lease who do not disturb the surrounding forest or wildlife unduly. But their huge unproductive cattle population cause a great deal of destruction, grazing and trampling and directly competing with wildlife to the latter's exclusion.

In Mudumalai sanctuary too many of the vayals are under cultivation in the Mudumalai reserve. The Tittimathi forests of Nagarhole are almost devoid of wildlife due to the very wide-spread Hadlu cultivations.

The best growth of the large bamboo (*Bambusa arundinacea*) is found along the edges of the marshes and elephants invariably congregate here. The soft soil and abundance of tubers and bulbs attract wild boar and most other herbivores. The preservation of marshes is most essential since they are the richest part of the ecosystem supporting a variety of wildlife, are the favoured haunts of elephants and also key-holders of the perennial stream flow. As a part of the ecosystem restricted to this locality and about which so little is known, for future studies at least some of these undisturbed marshes should be totally protected.

Scenically they are a most attractive feature of the sanctuary. The gently sloping hills with dark, rank vegetation and huge feathery bamboo clumps giving way abruptly to tall waving grass with small isolated thickets of trees and the streams along the centre with huge wild mango trees (*Mangifera indica*) and screw pine thickets are very beautiful.

Most of the fertile land along streams, river banks and most of the marshes are cultivated in Kerala Wynad either leased out by the forest department or from the revenue department. Since wildlife too prefers this type of habitat, conflict is unavoidable, predictably always to the detriment of the latter. Their very nature, encircling and isolating the forested hillocks, leads to the total fragmentation of the habitat once these marshlands are under cultivation. The remnants of the wildlife will have to run the gauntlet of guarded paddy fields or other cultivation to cross from one patch of higher ground to another where alone they can shelter from persecution. Hence the often voiced justification of ' crop protection ' gun and the menance from ' crop raiding wild animals '.

Specifically, the Ombatta Vayal and the Cheenakolli Vayals in Mudumalai should be completely protected. Similarly, the cultivators from the Kurichiyat Vayal and Golur Vayal in Kerala Wynad should be relocated, and these vayals be left as permanent resources

for wildlife. The hadlus in Nagarhole sanctuary should also be maintained intact.

In addition to these pockets of cultivation within the sanctuary, cultivation is encroaching on the wildlife habitat all along the periphery of the sanctuary. As mentioned above, most of the revenue forests are being released for cultivation. Cultivators have also encroached on many parts of former private and presently vested—forests in Kerala, the 25,000 acre Pulpally forest being the most striking example. Grant of further land within or on periphery of the forest for cultivation needs to be carefully watched.

(6) **Cattle :**

Together with large scale plantation activity and man-made fires, cattle constitute one of the foremost habitat degradating factors. In the survey area perhaps due to its plateau nature and accessibility from the human settlements all around and within, grazing forms a very severe threat to the forests. At present cattle grazing has been controlled to some extent only in the Bandipur Project Tiger area. (Photograph 9).

Controlling the grazing should involve differential approach to the cattle maintained by the cultivators, mostly chetties, within the forest and from the peripheral villages or settlements. For the former there is no option but to graze them in the forest all around. For the latter the revenue forests, maintained as Gomalas in Karnataka had also provided fodder but now that the revenue forests are vanishing ever so rapidly, the pressure on the reserve forests is increasing. The cattle, especially those kept by chetties are of very little productivity being mostly maintained for dung. For them a cheap system of converting vegetation to fertilizer, it is destructive for the habitat. Regeneration of vast areas of the forest is greatly curtailed or altogether stopped. The cattle churn up the mat of vegetation in the marshlands and trample down the soil elsewhere. The continuous trodding of hooves on slopping ground cause heavy erosional soil loss. The forest tracks are rendered impassable in wet as well as in the dry season by them. The cattle compete with wildlife for forage, scare away wildlife especially with the noisy wooden bells used in Wynad. They also very successfully transmit diseases to wildlife (the rinderpest outbreak that wiped out Gaur in Mudumalai-Bandipur area in 1968-69 was carried by cattle).

The graziers indulge in vandalism such as cutting down saplings, setting forest fires sweeping over this area, collecting forest products illegally etc. Bamboo shoots removed by these people affect bamboo regeneration to a hitherto unrecognised degree. In Kerala Wynad at least they are known to chase elephants out of the locality. It can be categorically stated that absolutely no area in the present Kerala Wynad sanctuary is free from grazing. The magnitude of destruction caused by cattle to Moyar-Masingudi area of Mudumalai sanctuary could be visualized by the fact that over 20,000 cattle are permitted to graze in this area for a very small grazing fee for which the mangy beasts are allowed to destroy the vegetation in this dry scrub area where regeneration is naturally slow. The following locations in the sanctuary complex appear to be alarmingly degraded due to cattle grazing though most of the land is overgrazed (see fig. 4).

Wynad wildlife sanctuary	*Mudumalai sanctuary*
Kavamad (In Kudrakote) Chambalam vayal (Begur).	Kunivayal and Thavanavayal in Benne Vellarankolli vayal area along Benne-Mudumalai road.